Creating Signal Coverage Contour Plots With Surfer Software from Measured Data Captured with ZTI Drive-Test Systems

Z Technology Application Note No: 26

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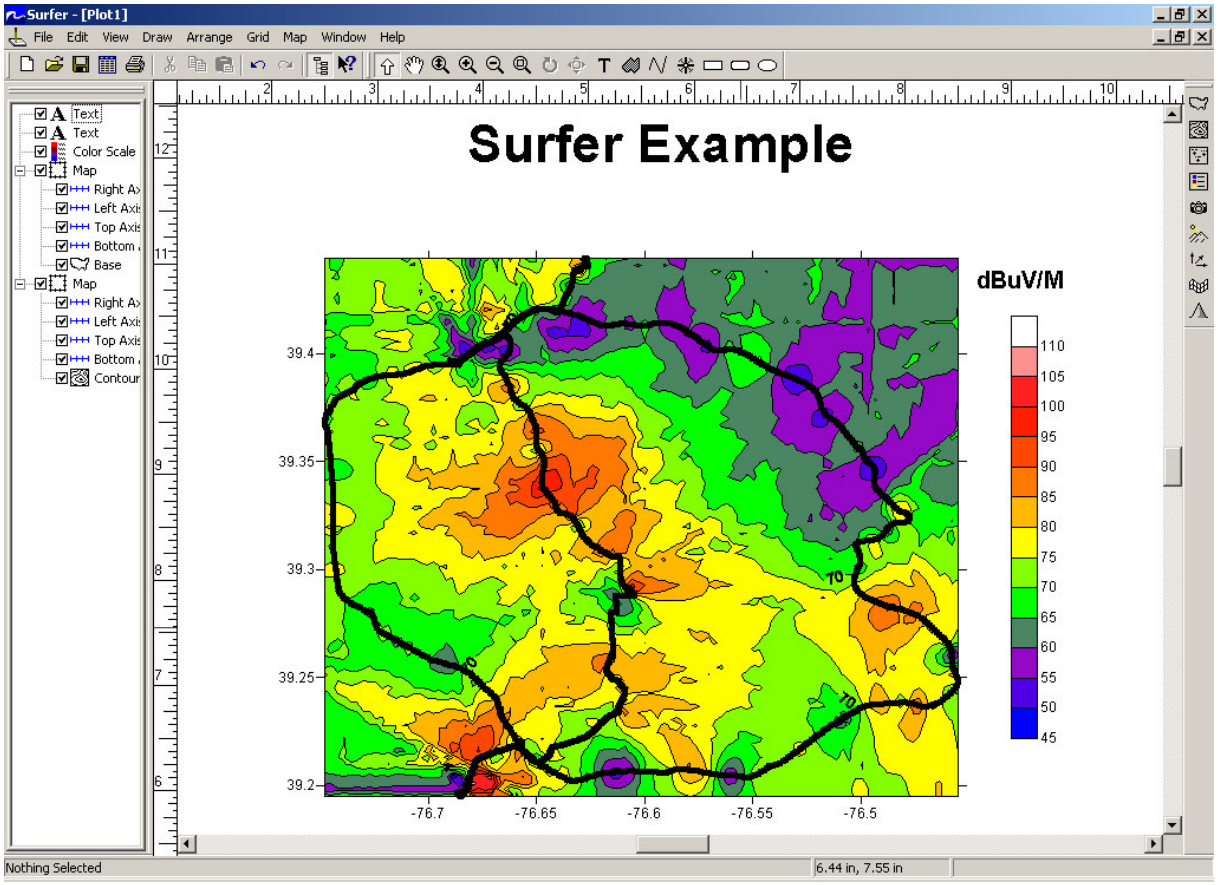

Surfer for Drive Test Application Note

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Introduction

This application note will describe how to export measurement data from a Z Technology DriveTest system to an intermediate data format suitable for importing into the Surfer 3D surface mapping program. A step-by-step process for an example drive will be shown. For variations on contour or surface mapping please see the included Surfer Users Guide.

Surfer by Golden Software is a commercial Contouring and 3D Surface Mapping program for Scientists and Engineers. It runs under Microsoft Windows 95/98/2000/XP. Surfer converts data into contour maps and surface plots. All aspects of 2D or 3D maps can be customized to produce unique presentations. Surfer can be purchased through Z Technology, or purchased directly from Golden Software at www.goldensoftware.com

For years, Z Technology (ZTI) has supplied Signal Coverage Drive-Test (D-T) Measuring and Mapping Systems to the broadcast and wireless industries. Our D-T Systems are specifically designed for accurate signal parameter measurements of terrestrial transmission networks. ZTI has developed a unique set of tools and special measurement parameters for use by the signal coverage analysis professional. These include several signal parameters directly correlate with the ability to receive, decode and process transmitted signals and/or data.

RF Signal Coverage Measurements

It was deemed highly desirable to record actual measurement parameters (such as accurate signal strength) at an exact location and then display that data precisely at the location where it was captured. Using multiple measurements and associating each measurement with a GPS latitude and longitude, a 'coverage' map of an area of service was generated. This map can be displayed, in color, by our Drive Test Systems Application software. These maps consist of a series of colored dots overlaid on top of a geographic region. Data can be analyzed for each location by observing the color-coding of the displayed data. This generates colorful and very useful plots of parameters such as signal strength, decoder locks, signal to noise ratios, etc. In addition, the ZTI Application also provides a unique Drill-Down feature for examining in detail information collect at various data points. Drill-Down lets the user examine all captured data for one GPS location or across an entire series of locations. The Drill-Down feature, along with the color-coded plot presentations, have proven to be an excellent tool for characterizing overall coverage for a transmission network.

Recently, some users have requested the ability to have one additional method of displaying collected Drive Test data. This need arises for users doing management presentations or when there is the requirement to describe coverage parameter values *everywhere* within a service area. In these cases, it is helpful to be able to extrapolate from measured Drive-Test data and create signal coverage maps to give

estimates of expected coverage for all points across an entire service area. By using what we know from measured signal information at a finite number of locations, it is possible to mathematically calculate the expected values that would be measured if one were able to collect data over an entire service area. Of course, some assumptions must be made and math based on those assumptions employed. When this is effectively done complete extrapolated signal coverage maps can be generated.

Contouring

There are several Windows based programs available today that allow us to accomplish this task. These programs rely on a variety of mathematical models to generate a complete signal coverage map even when only a limited number of measured data points are available. These programs create pictorial views of a coverage area. The views can be rendered as 2- dimensional Contour Plots representative of the various parameters relating to signal coverage.

The remainder of this Application note will cover how to create Contour Plots using the **Surfer®** application.

If you have purchased Surfer with a Z Technology DriveTest system, an example plot of a Baltimore UHF DTV station is included. This application note will describe the steps to:

- Export DriveTest data to a ".dat" file that can be imported into Surfer
- Import the ".dat" file into surfer to create a ".grd" grid file
- Use Surfer to create a Map Contour display
- Change the Base Map symbol
- Set up a color scale
- Add a title to the contour map
- Open the DriveTest .shp layer file to create a drive background

Downloading and installing Surfer on your PC is a straightforward process. Follow the instructions found on the Golden Software website. Once you have the program operational on your computer you are ready to move to the next step of preparing collected drive test data for use by this Application. If you have purchased Surfer with your DriveTest system, the program is already installed on the system PC and ready to use.

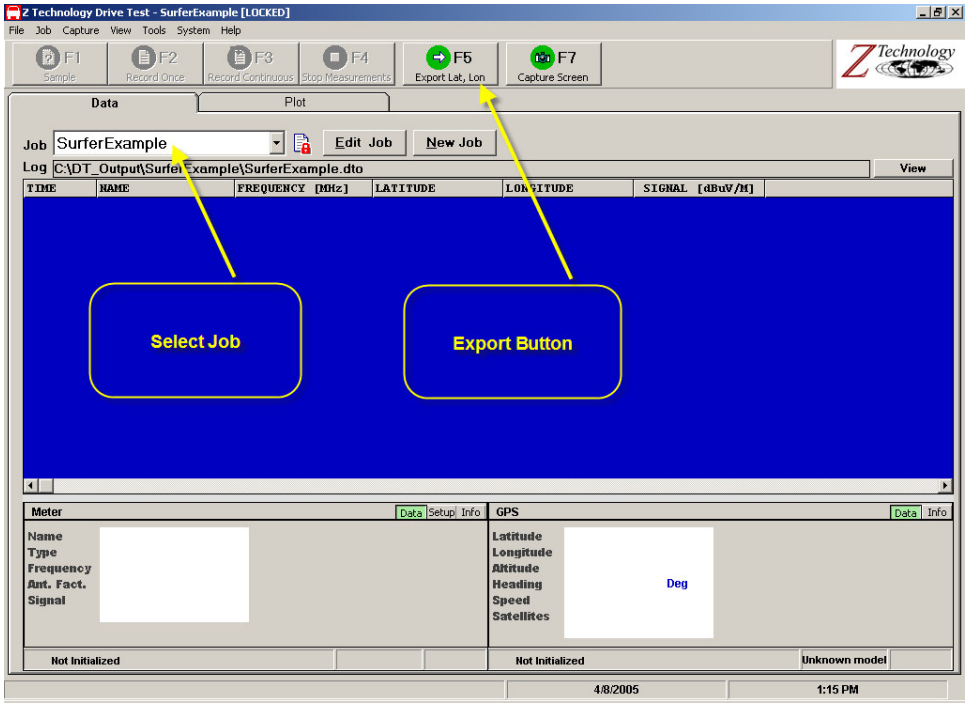
Surfer requires data to be formatted in a specific way. The file must have three columns of data separated by commas. A correctly formatted file will be structured as follows with the first column containing longitude values, the second latitude values and the third column the measured parameter to be plotted. An example is given here:

```
 Longitude,Latitude,Integrated Pwr[dBuV/M]
-76.685970,39.196968,60.4
-76.685972,39.196968,60.3
-76.685920,39.196932,60.5
```

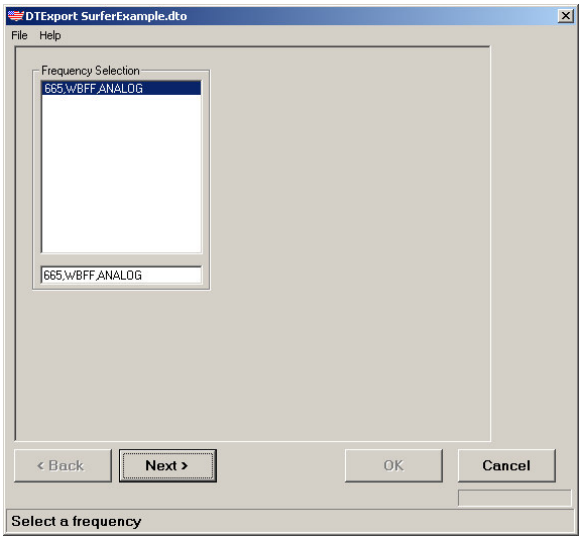
```
-76.685923,39.196932,60.5
-76.685925,39.196933,60.5
-76.685927,39.196933,60.2
-76.685930,39.196935,60.5
-76.685930,39.196937,60.6
-76.685932,39.196937,60.2
-76.685933,39.196938,60.1
-76.685935,39.196938,60.2
-76.685935,39.196940,60.2
-76.685937,39.196942,59.8
-76.685922,39.196953,59.9
-76.685918,39.196957,60.1
-76.685922,39.196957,60.0
-76.685928,39.196955,59.5
```

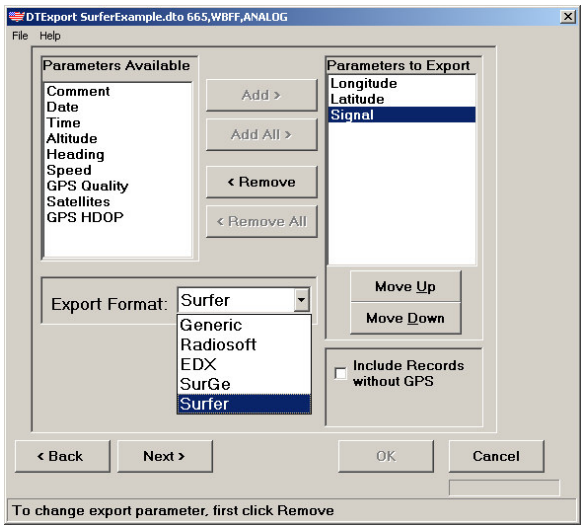
Export DriveTest data to a ".dat" file that can be imported into Surfer

It is easy to create a data file of this format by simply using the Export feature of the DriveTest Application. Within DriveTest open the job you wish to work on, in this example we use "SurferExample" then click on the Export Lat Lon button.



With the Exporter open, double click on the frequency you want to create a contour plot for. In this example there is just one frequency that has been recorded.



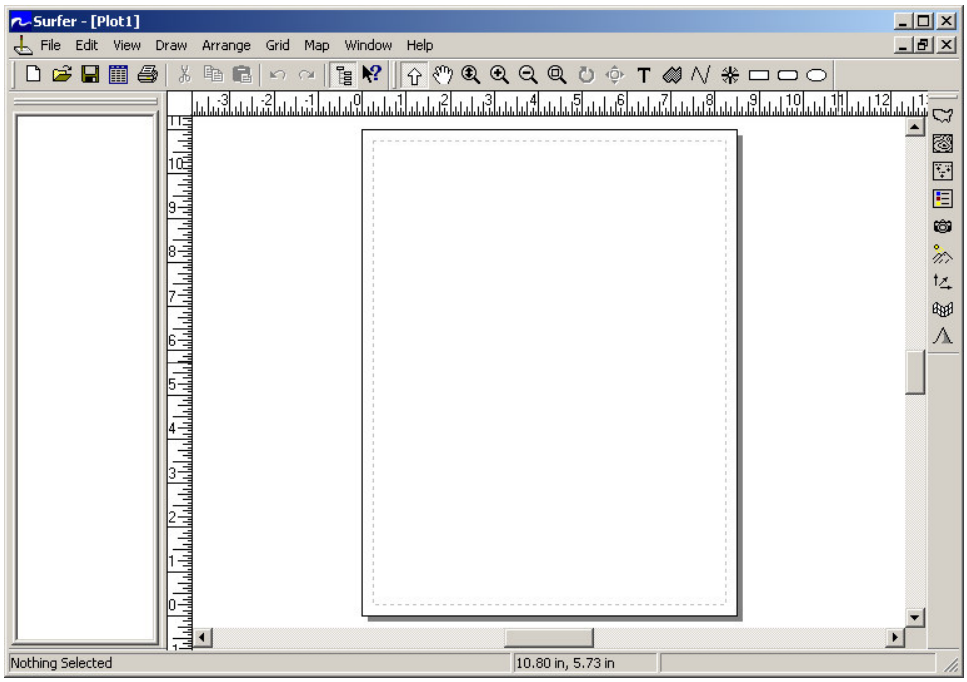


Double click on the frequency, on the next screen under "**Export Format**" select "**Surfer**" then click "**Next**". A progress bar appears followed by a screen asking if you would like to export another frequency. Click "**No**". The Exporter screen disappears and the DriveTest screen re-appears. Close DriveTest by clicking on the "X" in the upper right corner. A ".dat" data file has been created for import into Surfer.

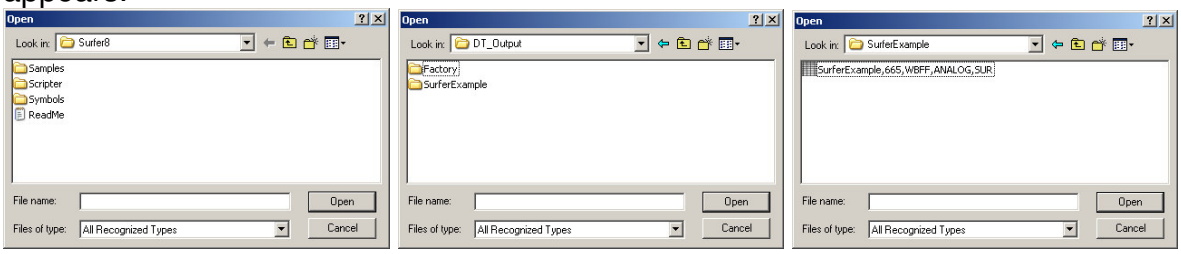
The file resides in the C:\DT_Ouput folder for the current job, in this example:
C:\DT_Ouput\SurferExample.
The file name automatically created in this example is:
SurferExample,665,WBFF,ANALOG,SUR.dat
Where 'SUR' designates it was exported in Surfer format.

Import the ".dat" file into surfer to create a ".grd" grid file

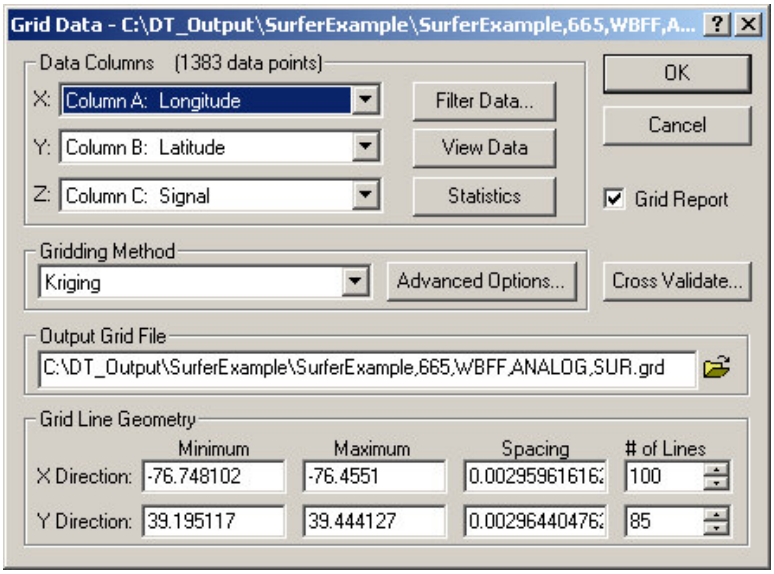
Start Surfer by clicking on the Surfer Desktop icon or clicking on the "**Start**" button then click "**All Programs**", "**Golden Software Surfer 8**", then "**Surfer 8**". The Surfer screen appears.



Click on the "**Grid**" Menu, then click on "**Data …**". An "Open" browsing window appears.



Click on the down arrow by the Surfer folder shown in the left screen above. Select **C:**, then select **DT_Ouput**, then select **SurferExample**. Click on **SurferExample,655,WBFF,ANALOG,SUR** then click on the "**Open**" button. The GridData window appears.

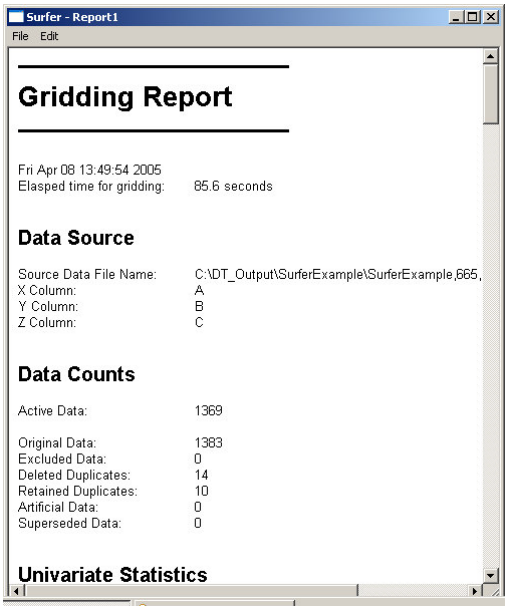


Click the "**OK**" button.

The Surfer main screen re-appears with a message "Gridding using kriging with sector search" in the status line at the bottom of the page, while a status bar grows showing the progress of the gridding process. A completion message appears when the process finishes.

Click the "**OK**" button.

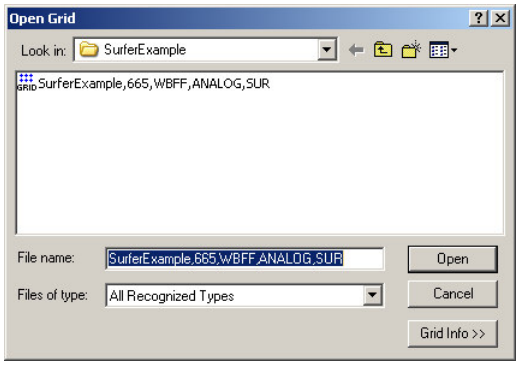
The Surfer Gridding Report appears.



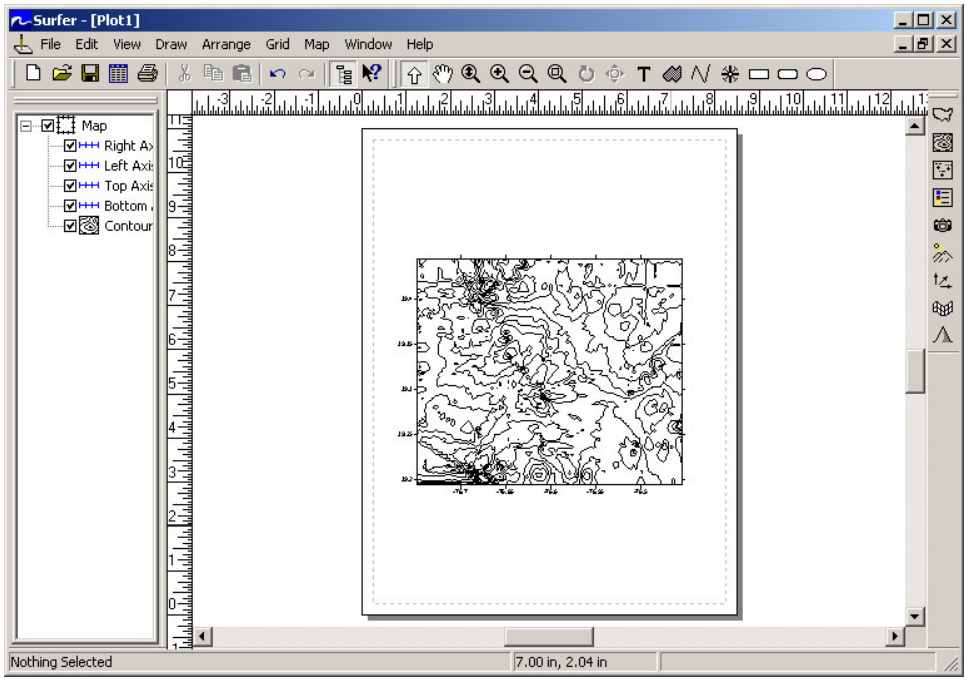
Close the Gridding report by clicking on the "X" in the upper right corner. When the "Save Changes" message appears click "**YES**", on the next screen click "**Save**"

Use Surfer to create a Map Contour display

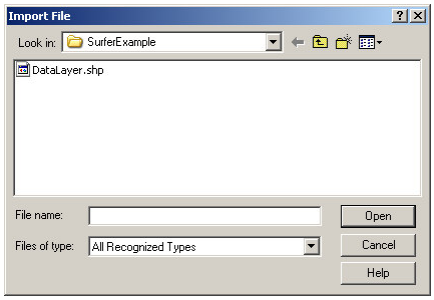
Back at the main Surfer Screen click on the "**Map**" Menu item, then click on "**Contour Map**", then click "**New Contour Map**". The "Open Grid" window appears.



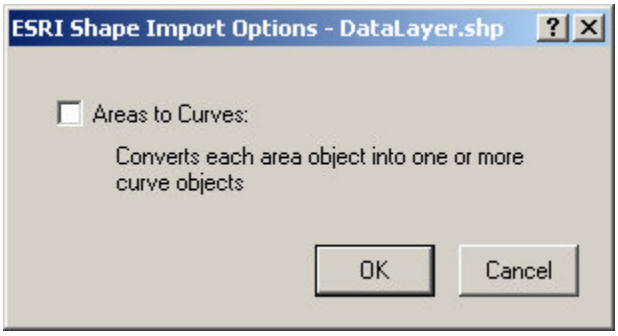
Check that "SurferExample,665,WBFF,ANALOG,SUR" is selected, then click the "**Open**" button. The Surfer window appears with the new contour data displayed in black and white.



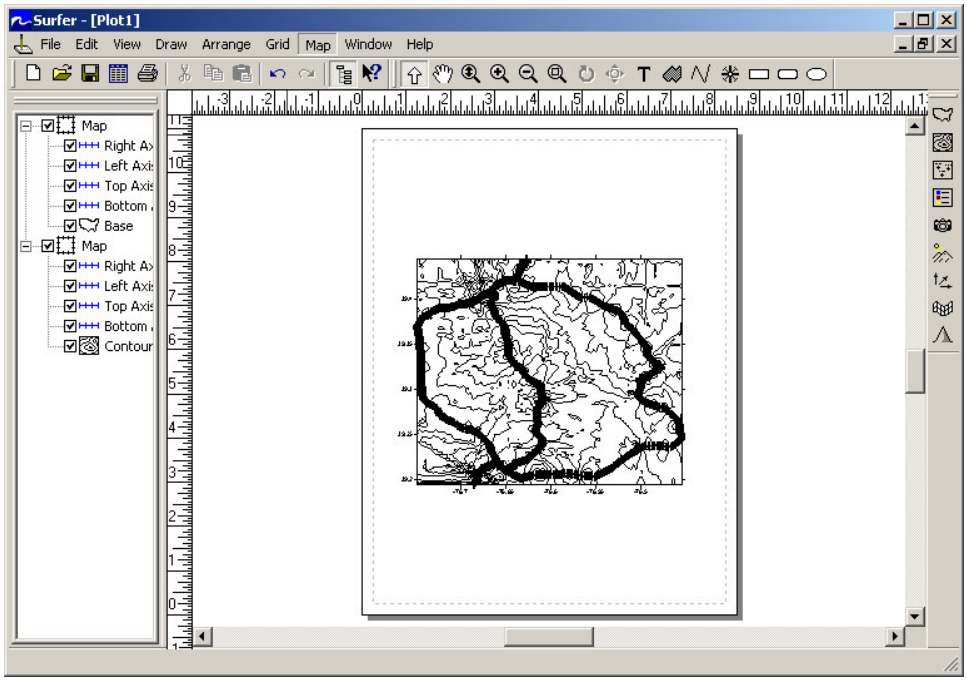
Next load the base map, which shows the original route and location of measurements. Click the "**Map**" menu, then click "**Base Map …**" a "Import File" browse window appears.



The browse window automatically open the C:\DT_Output\SurferExample folder. Click on "**DataLayer.shp**" to select it, then click on the "**Open**" button. (The DataLayer.shp file is an ESRI shape file created by DriveTest as measurements are made. It contains the graphic information to display the measurements on the DriveTest built in Maps.) An "ESRI Shape Import Option – DataLayer.shp" screen appears, Click "**OK**".

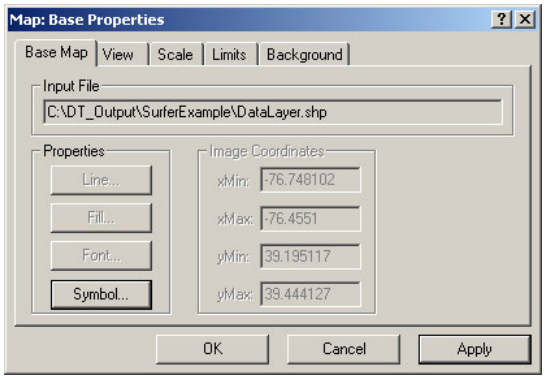

ESRI Shape Import Options - DataLayer.shp
Areas to Curves:
Converts each area object into one or more curve objects
OK
Cancel

The Surfer screen now shows the path driven to collect the measurement data.

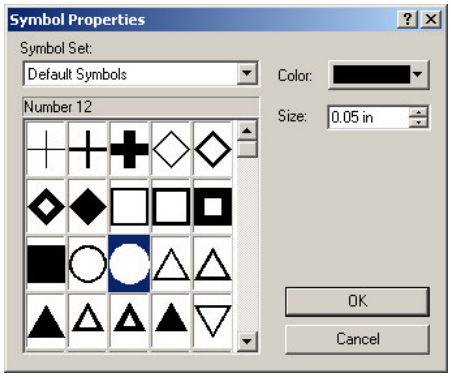


Change the Base Map symbol

The default base map symbol is a large “X” for better view ability we will change it to a smaller dot. Double click on the “Base” entry in the left column on the screen. The base Map Properties screen appears.



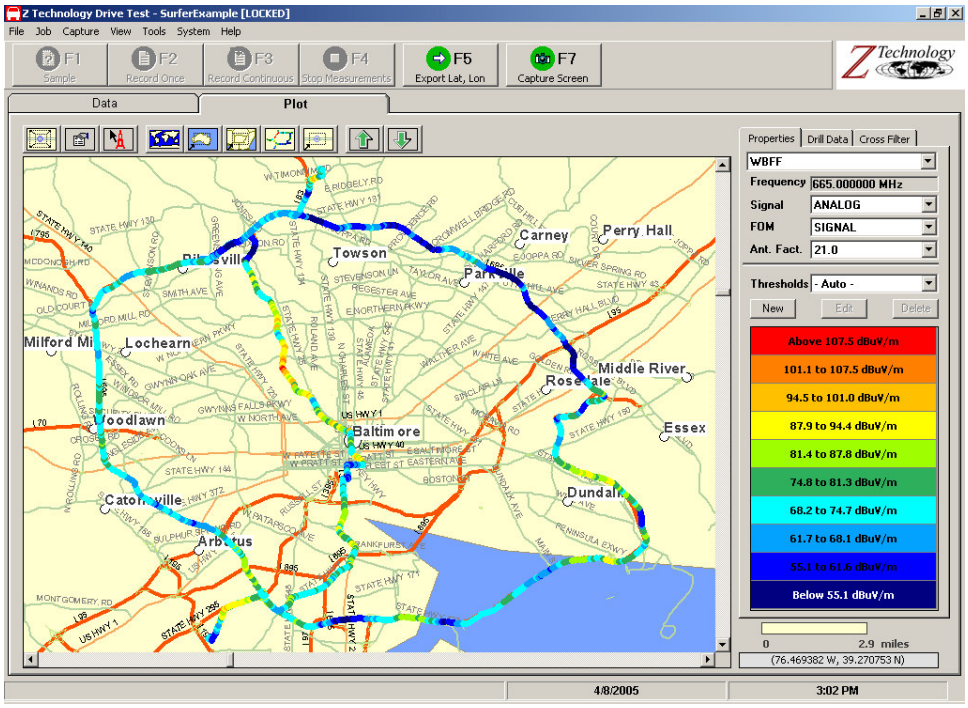
Click on the “**Symbol …**” button. The Symbol properties screen appears.



Select the solid circle, and change the size from “0.15 in” to “0.05 in.” Then click the “**OK**” button, then click the “OK” button again. The Surfer screen re-appears now with the base map as small dots instead of larger “X’s”.

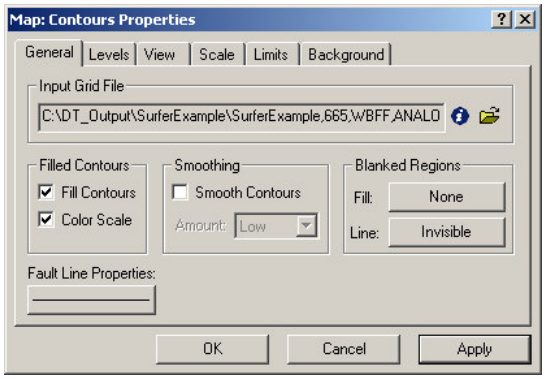
Set up a color scale

The map contours need some color. We will set up colors to approximate the colors of the original DriveTest data. Within DriveTest the PLOT page looks like the following.

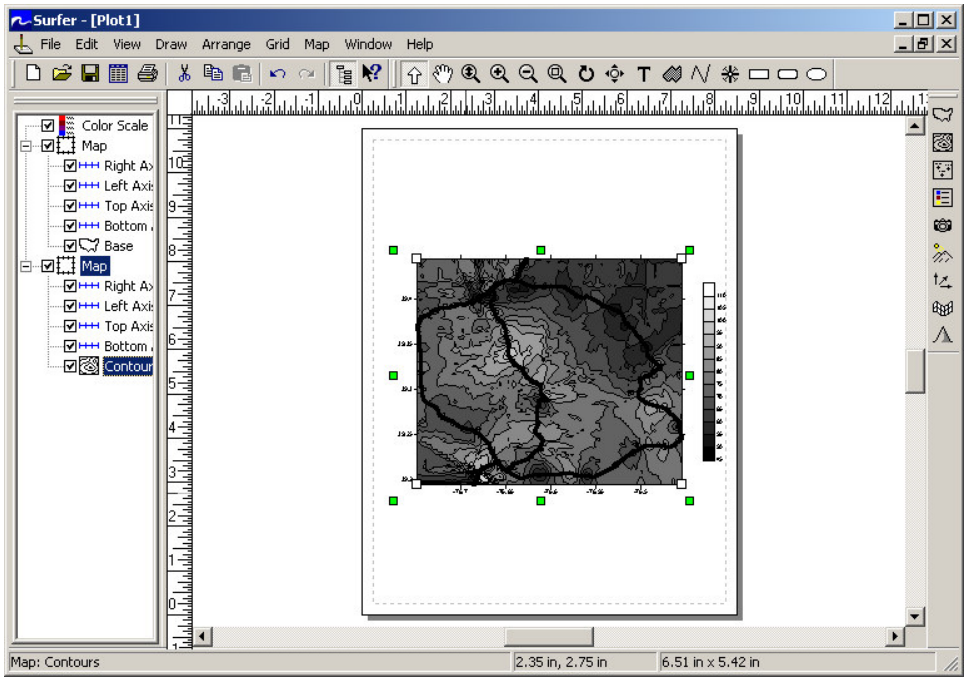


In the next operation we will approximate the color scale on the right of the DriveTest Plot Page into the Surfer contour data.

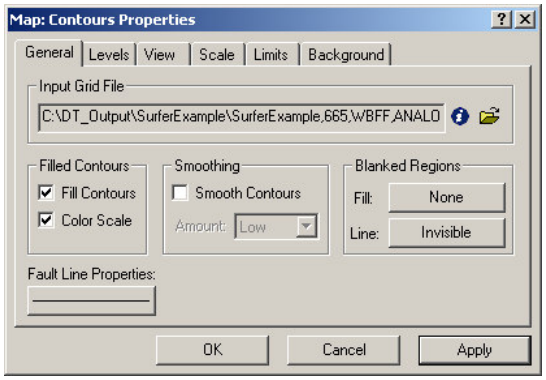
On the Surfer screen double click on the "**Contour**" entry in the left column. The "Map:Contours Properties" screen appears.



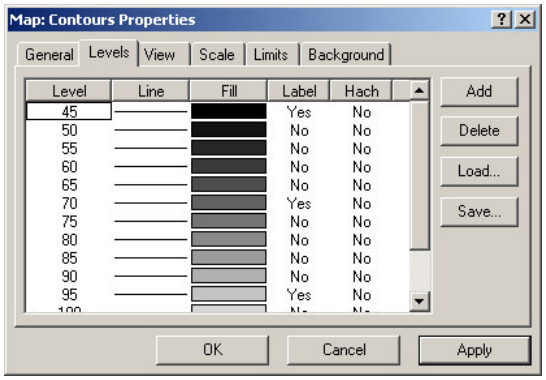
In the "Filled Contours" box check "**Fill contours**", and check "**Color Scale**" then click on the "**OK**" button. The main Surfer screen re-appears with a gray scale color plot and color scale at the right margin.



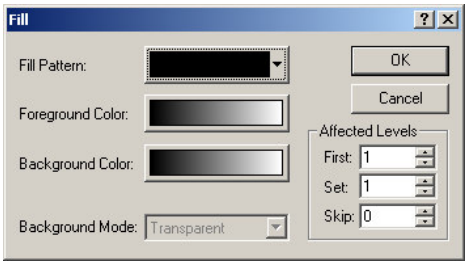
The next step is to change the grey scale to a color scale that approximates the color scale of the original DriveTest PLOT.
Double click on the "Contours" again. The "Map:Contours Properties" screen appears.



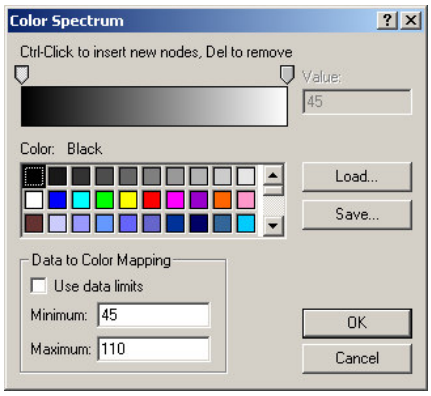
Click on the "**Levels**" tab, the "Level's tab screen appears.



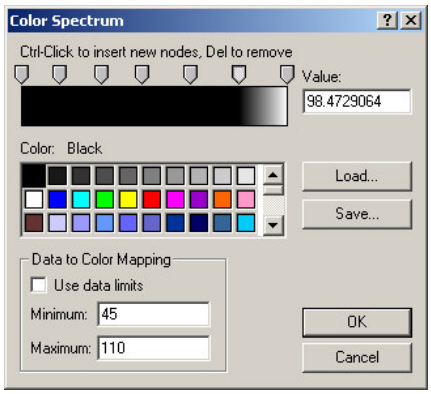
Click on "**Fill**", the "Fill" screen appears.



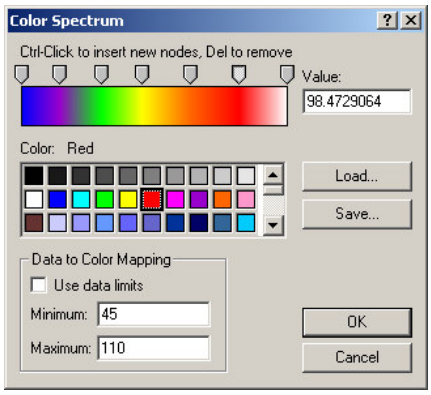
Click on the "Foreground Color:" box. The color Spectrum box appears.



Notice there are two "nodes" at each side of the color spectrum box. By moving the cursor above the box (that now shows a grey scale) and holding the control key down you can click to add a node. Add 5 evenly spaced nodes like shown in the example below.



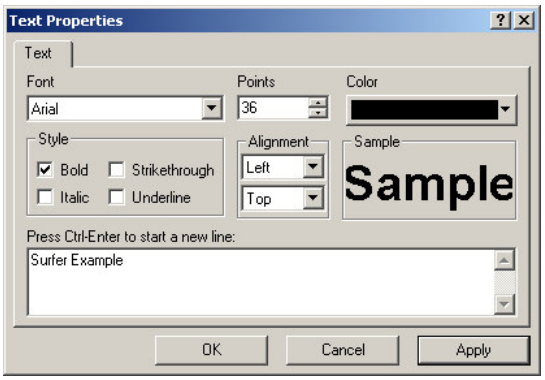
Now click on the very left node to select it. This represents the very lowest signal level. With the left node selected click on the Blue color box.
Click the 2nd node then click on the Purple color box.
Click on the 3rd node then click on the Green color box.
Click on the 4th node then click on the Yellow color box.
Click on the 5th node then click on the Orange color box.
Click on the 6th node then click on the Red color box.
The Color spectrum screen now looks like the following.



Click the "**OK**" button. Click "**OK**" again, then click "**OK**" again. The main Surfer screen re-appears with the color contouring visible.

Add a title to the contour map

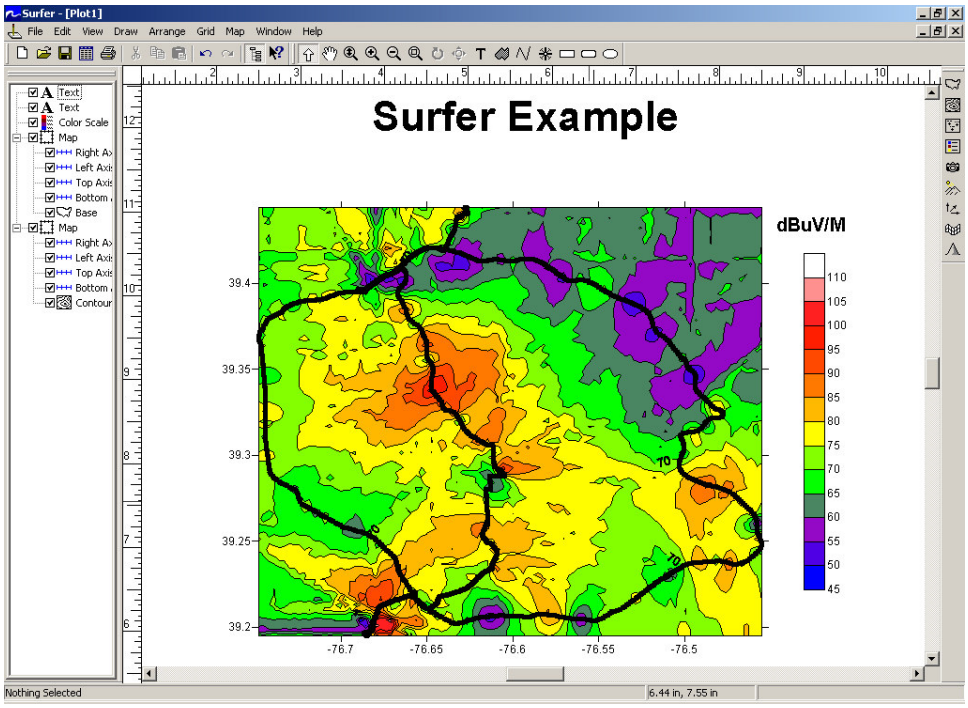
On the Surfer main screen click on toolbar Text icon , then click on the top white space above the contour plot. A text edit window appears.



Type in a title for the contour map. In this case we use the title "Surfer Example" change the Point size to 36, check the "Bold" box then click "**OK**" The text appears in the white space where you clicked earlier. If it is not quite centered, click on the toolbar pointer arrow then click on the title to select it the drag it to a new centered position.

Next add a units label for the color scale on the right side of the screen. Referring back to the DriveTest PLOT we see that the original measurement units were "dBuV/M". Click on the toolbar Text icon . Click on a white space above the color scale. Enter "dBuV/M" then change the points to 16, check the "Bold" box then click "**OK**". Use the toolbar pointer arrow to position the new label.

The contour map is now complete. You may print it using the printing instructions described in the Surfer User Manual.



Click on the “File” menu, then click on “Save”. A Save As box appears with a file name “plot1” click the “Save” Button and your plot has been saved in the C:\DT_Output\SurferExample folder with a file name Plot1.

Summary and Additional Information

More measurement data can always be added to an existing Drive Test. This can be done at a later time by simply placing the Drive Test System back into a vehicle, calling up the original *Job* and begin taking more data. After finishing the new measurement session with the Drive Test System, again use the DriveTest Export button to create a new .dat file for use by Surfer. This new file will contain all the pertinent data from both the original and the new measurement sessions. Surfer will need to generate a second Contour Plot by using the new full set of measurement data points.

This approach allows one to improve the accuracy of Contour Plots by adding more actual measured data to the input file used to calculate contours. The more measured values used the better the accuracy of a Contour Plot.

Contour Plots provide another tool to evaluate, analyze and display signal coverage measurements. They can be a valuable tool for estimating coverage beyond the actual measured locations and can provide extrapolations of expected coverage over an entire service area. The method described here is an excellent addition to an engineer’s tool-set for understanding performance of a single RF transmitter or an entire wireless or broadcast network.

Of course, Surfer and all other Contouring programs have their limitations (for example in this demonstration we’ve not directly take into account terrain or man-

made obstructions.) When this is understood, the operator can make full and effective use of Contour Plots.

Always remember if actual and precise data is required at a specific location, the best approach is to take real measured data at that location using one of Z Technology's Drive Test Systems.

DSS5800 Drive Test System by Z Technology, Inc.